

PHYS393 Statistical and Low Temperature Physics

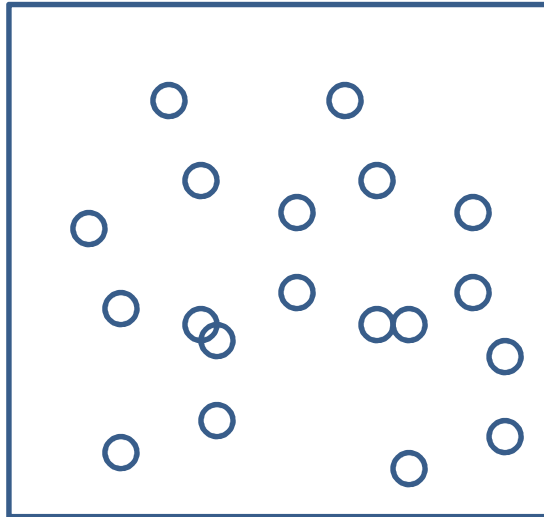
10. The Real World

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We have so far considered systems of particles for which the total number of particles and the total energy remain constant.

In the real world, this is seldom the case.

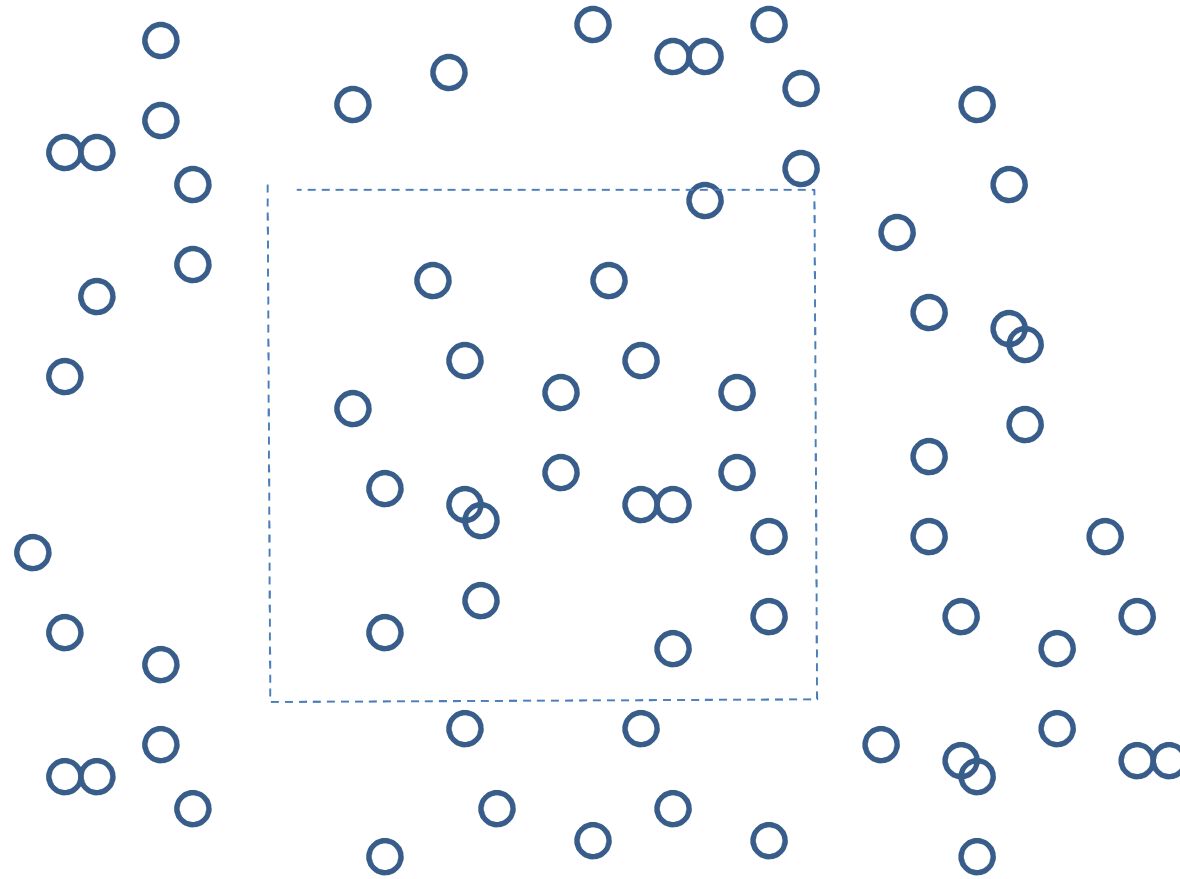
In a box of gas, although the number of atoms may be fixed, ...



... there would always be exchange of heat with the surrounding through conduction or radiation.

As a result, the total energy is not fixed.

If it is an imaginary box within a gas ...



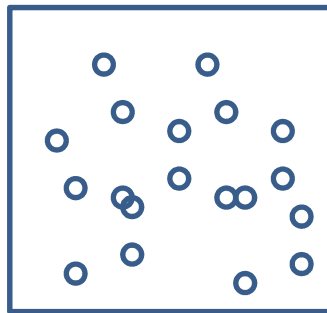
... then even the total number of particles would not be fixed.

In order to include the effects of the changes in particle number and energy, the physics of three types of systems have been studied:

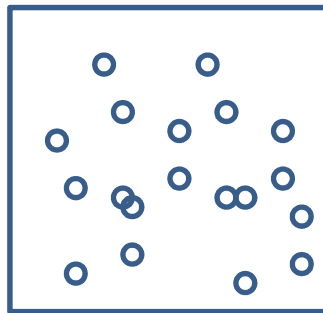
1. Microcanonical ensemble
2. Canonical ensemble
3. Grand canonical ensemble

Microcanonical ensemble

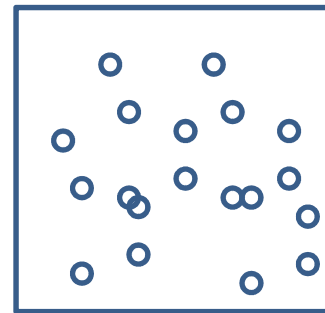
This is a collection of microstates for which ...



Microstate 1



Microstate 2



Microstate 3

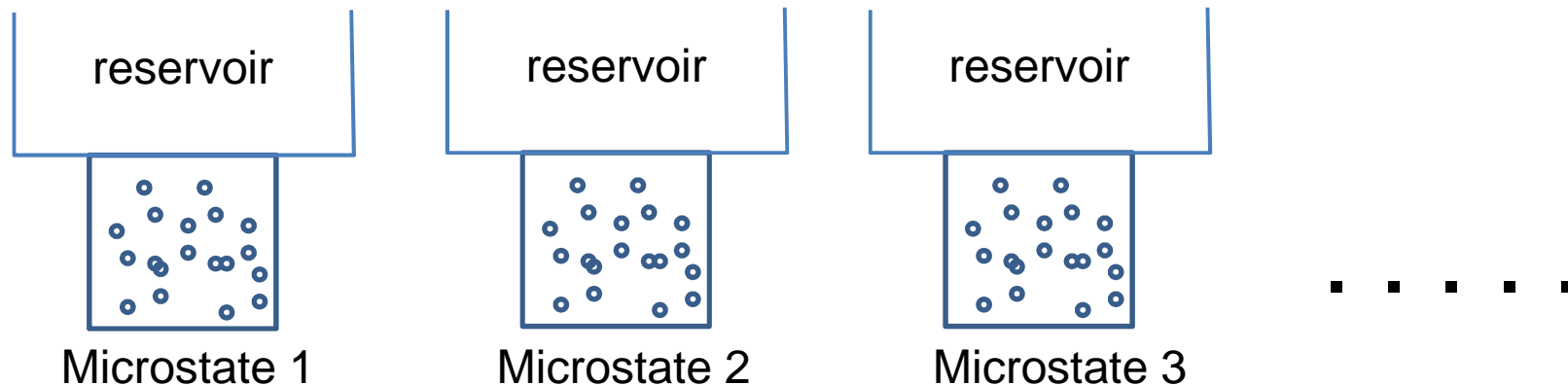
■ ■ ■ ■ ■

... the total number of particles and the energy are both fixed.

This is an isolated system. (Like the universe?)

Canonical ensemble

This is a collection of microstates for which ...

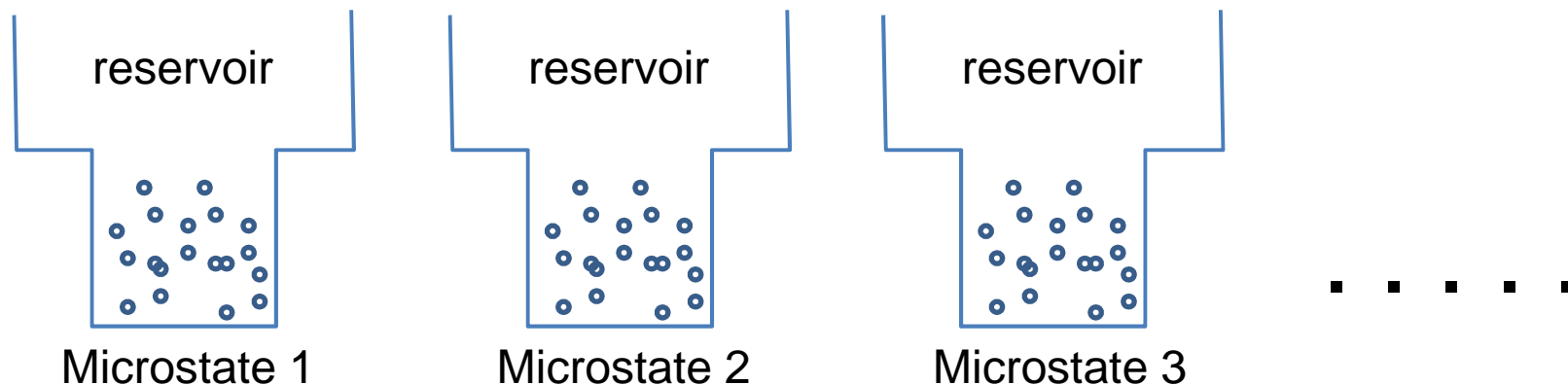


... the total number of particles is fixed, but the energy can be exchanged through contact with a large object (reservoir).

This is a closed system. (Like a bottle of gas in the atmosphere.)

Grand canonical ensemble

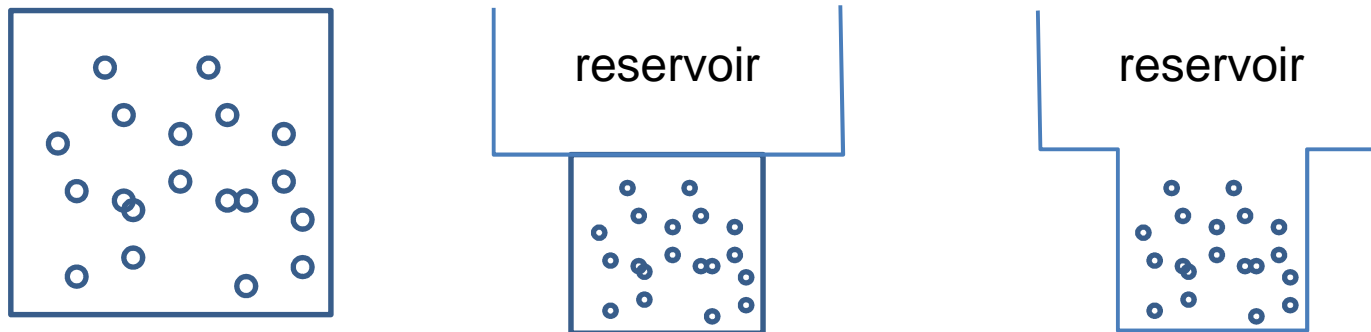
This is a collection of microstates for which ...



... both the particles and the energy can be exchanged with a reservoir.

This is an open system. (E.g. A lump of sugar in a cup of coffee.)

By studying these three types of ensembles ...



... it is possible to learn more about real systems.

(More details on canonical ensembles can be found on Wikipedia.)

Thank you and good luck.